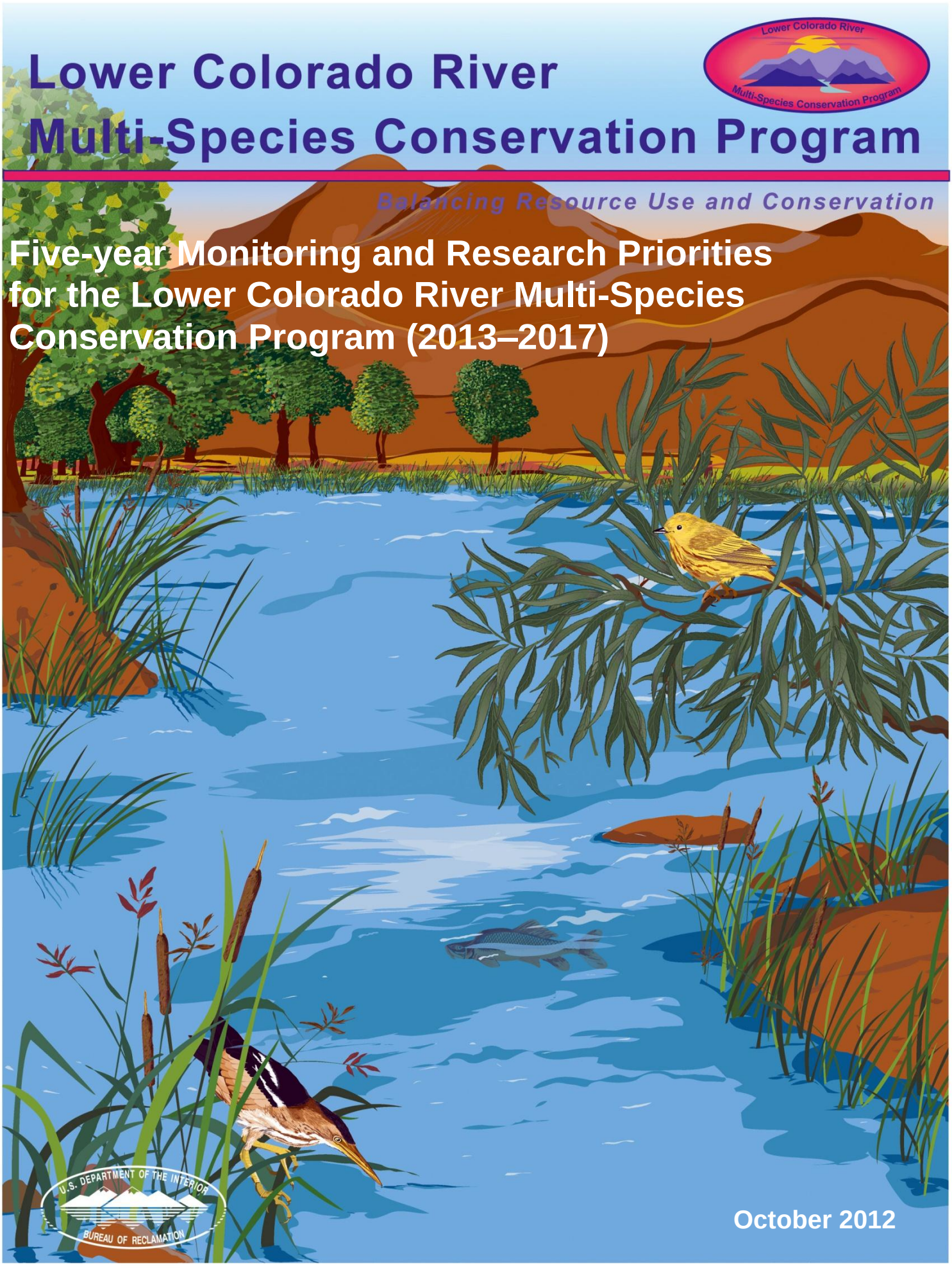
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Five-year Monitoring and Research Priorities for the Lower Colorado River Multi-Species Conservation Program (2013–2017)



U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

October 2012

Lower Colorado River Multi-Species Conservation Program Steering Committee Members

Federal Participant Group

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

Arizona Participant Group

Arizona Department of Water Resources
Arizona Electric Power Cooperative, Inc.
Arizona Game and Fish Department
Arizona Power Authority
Central Arizona Water Conservation District
Cibola Valley Irrigation and Drainage District
City of Bullhead City
City of Lake Havasu City
City of Mesa
City of Somerton
City of Yuma
Electrical District No. 3, Pinal County, Arizona
Golden Shores Water Conservation District
Mohave County Water Authority
Mohave Valley Irrigation and Drainage District
Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
Town of Fredonia
Town of Thatcher
Town of Wickenburg
Salt River Project Agricultural Improvement and Power District
Unit "B" Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users' Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

Other Interested Parties Participant Group

QuadState County Government Coalition
Desert Wildlife Unlimited

California Participant Group

California Department of Fish and Game
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
Southern California Public Power Authority
The Metropolitan Water District of Southern California

Nevada Participant Group

Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
Chemehuevi Indian Tribe

Conservation Participant Group

Ducks Unlimited
Lower Colorado River RC&D Area, Inc.
The Nature Conservancy

Lower Colorado River
Multi-Species Conservation Program

Five-year Monitoring and Research Priorities for the Lower Colorado Multi-Species Conservation Program (2013–2017)

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ACRONYMS AND ABBREVIATIONS

AMM	avoidance and minimization measures
BONY	bonytail
ELOW	elf owl
FLSU	flannelmouth sucker
FY	fiscal year
GBBO	Great Basin Bird Observatory
ha	hectare(s)
HCP	Habitat Conservation Plan
km	kilometer(s)
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
m	meter(s)
MAPS	Monitor Avian Productivity and Survival
mm	millimeter(s)
MRM	monitoring and research measures
PIT	Passive Integrated Transponder
RASU	razorback sucker
Reclamation	Bureau of Reclamation
SWFL	southwestern willow flycatcher
TL	total length
USGS	U.S. Geological Survey
YBCU	yellow-billed cuckoo

Symbols

%	percent

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INTRODUCTION

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a multi-stakeholder, Federal, and non-Federal partnership responding to the need to balance the use of lower Colorado River (LCR) water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act. This program is a long-term, 50-year plan to conserve at least 26 Federal and State-listed candidate and sensitive species along the LCR, from Lake Mead to the Southerly International Boundary with Mexico, through the implementation of a Habitat Conservation Plan (HCP) (LCR MSCP 2004a). The Bureau of Reclamation (Reclamation) is the entity responsible for implementing the LCR MSCP. A Steering Committee, currently consisting of 54 entities, was formed as described in the *LCR MSCP Funding and Management Agreement* (LCR MSCP 2004b) to provide input and oversight functions in support of LCR MSCP implementation.

The HCP conservation measures were designed to meet the biological needs for 26 covered species and potentially benefit 5 evaluation species included in the LCR MSCP. The HCP provides program-level guidance for ensuring that implementation of the conservation measures will be based on scientific information, methods, principles, and standards. Through utilization of adaptive management principles, new information obtained on species and their habitats can be used to implement biologically effective and cost-efficient conservation actions. The HCP acknowledged the need for implementing research and monitoring priorities within the first 20 years of the LCR MSCP period; implementation costs for monitoring, research, and adaptive management reflect these priorities (HCP Table 7-1).

A *Final Science Strategy* was drafted in August 2006 and finalized in October 2007, which outlines the adaptive management process (LCR MSCP 2006a). The Science Strategy describes a two-tier planning process to ensure effective implementation of research and monitoring actions: (1) a 5-year planning cycle and (2) annual work plans. Every 5 years, a plan will be developed that describes the current knowledge for covered species and their habitats, priorities for research and monitoring to provide additional information needed over each ensuing 5-year period, and any potential challenges that may inhibit successful implementation of the scientifically sound conservation measures. An annual work plan that summarizes prior year accomplishments, describes current year ongoing activities, and outlines the proposed activities for the coming fiscal year (FY) is presented to the Steering Committee each year. These annual work plans enable adaptive management to occur in a timely manner and ensure implementation of 5-year priorities.

A four-step process for identifying 5-year priorities is described in the Science Strategy:

(1) Identify current knowledge and data gaps
(2) Initial ranking of data needs
(3) Review initial data ranking and propose priorities
(4) Determine final data need priorities

Annual priorities are established during the work plan process as described in the Science Strategy. The first priority is the continuation of long-term research and monitoring projects identified and implemented during prior planning. Additional information obtained through these research and monitoring programs determine the need for additional data. These data are prioritized by balancing need with potential annual budgets as described in Table 7-1 of the HCP (LCR MSCP 2004a). Priorities may shift as new information is obtained, opportunities are identified, and adaptive management recommendations are adopted.

The first 5-year planning cycle for LCR MSCP implementation covered FY08 through FY12. This document outlines the accomplishments from 2008 through 2012 of the monitoring and research priorities for each implementation element described in the HCP: fish augmentation, species research, system monitoring, post-development monitoring, and restoration (created habitat) research.

This document also provides the 5-year research and monitoring priorities covering years 2013 through 2017; it includes all of the above implementation elements and individual covered species, species guilds, and/or their habitats needed to successfully implement conservation measures described in the HCP. Priorities have been established based on information outlined in the species accounts completed in 2007 (LCR MSCP 2007a), through extensive additional literature searches, through research and monitoring information gained in the period of 2008 through 2012, and through outreach to partners and other interested parties. The research and monitoring priorities listed below for the 2013 through 2017 period are described broadly. For more specific information on a priority, refer to the work task associated with it in the annual work plans.

New data accumulated from research and monitoring activities will be reviewed throughout this 5-year planning cycle. The results of research and monitoring activities outlined in this document will be evaluated during FY17, and new priorities will then be established for the next 5-year cycle (2018–2022).

FISH RESEARCH AND MONITORING

The following section describes the LCR MSCP fish activities, including fish augmentation, species research, system-wide monitoring, post-development monitoring, and restoration research. The information provided includes accomplishment of activities for FY08 through FY12. Information obtained through these activities has led to additional research and monitoring priorities listed as proposed activities for FY12 through FY17.

Fish Augmentation

Accomplishments 2008–2012

Much of the current capability for fish augmentation stems from research and development at the Willow Beach National Fish Hatchery, Achii Hanyo Rearing Facility, and Bubbling Ponds State Fish Hatchery between 1994 and 2005. Considerable work was involved with learning how to feed, grow, and treat these fishes. Much of the basic knowledge of, and refinements to, the culture of razorback sucker (RASU) and bonytail (BONY) were developed prior to 2008 as the result of LCR MSCP efforts in cooperation with Federal and State fish hatcheries as well as researchers throughout the region. Because of the previous work completed, the time between 2008 through 2012 was not a period of major advancement in the knowledge of the culture of these species, with the various hatcheries slightly improving their techniques and focusing on producing as many large fish as possible. The current rearing program also continues to benefit from field observations made on juveniles in rearing ponds, adults on spawning grounds, and radio and sonic tracking activities, all accomplished by LCR MSCP partners prior to signing the Record of Decision.

Examples of the further refinement of rearing practices include the work completed under Work Task C26, Evaluation of Raceway Rearing of Razorback Sucker at Lake Mead Fish Hatchery, between 2008 and 2011. These studies proved that RASU "conditioned" in flowing water grew fast, with better food conversion efficiency, and were able to swim longer before exhaustion. These traits may significantly improve survival post-stocking. The results of this Work Task are summarized in two reports: *Evaluation of Rearing Razorback Sucker (Xyrauchen texanus) in Flowing Raceways at Lake Mead Fish Hatchery* and *Final Evaluation of Flow Conditioning Razorback Sucker (Xyrauchen texanus) in Flow-Through Raceways at Lake Mead Fish Hatchery*.

Other work refinements or advances in rearing practices that occurred between 2008 and 2012 include the feed findings under Work Task C11, Bonytail Rearing Studies, conducted mostly at the Dexter National Fish Hatchery and Technology Center. Researchers discovered that BONY fed a diet specially formulated for RASU grew faster than when fed a more trout-oriented diet. This was surprising

and useful information, as BONY are piscivorous and it was expected the higher protein values in diets for other piscivorous fish would be most suitable. This work was summarized in a final report in 2010, *Diet Optimization and Growth Performance of Bonytail (Gila elegans) Reared in Outdoor Ponds*. Another important refinement that lead to increased rearing capacity was the recognition, as the result of multiple studies at several Federal and State hatcheries, of the role that fish density in ponds plays in growth rates and how the optimal density for RASU and BONY grow out ponds varies by facility and even by pond.

Proposed 2013–2017

The LCR MSCP Fish Augmentation Program is committed to providing the level of funding necessary to produce up to 660,00 sub adult RASU of at least 300 millimeters (mm) in total length (TL) as well as up to 620,000 BONY of at least 300 mm TL into the LCR (LCR MSCP 2006b). The numeric goals for fish augmentation may be revised downward if the minimum size for acceptable survival increases due to the extra cost of raising larger fish for stocking. There are two focus areas for monitoring and research under the Fish Augmentation Program between 2013 and 2018: (1) fish distribution methods and (2) fish size and condition at stocking.

Although the fish augmentation portion of the HCP does not dictate goals for fish survival post stocking, making all possible efforts to ensure adequate survival continues to be a priority. To date, the survival of stocked fish has not met expectations and has ranged from 0.1 to 0.9 percent (%) in Lake Mohave. These results are very similar to the survival rates noted for RASU in the upper Colorado River. It should also be noted that RASU stocked into Lake Mohave do not count towards the overall program goal, but are meant to help stabilize the Lake Mohave population as a genetic refugia. The low survival rate for stocked fish is likely the result of a combination of inadequate habitat and predation by birds and non-native fish species. These two factors interact with each other to some degree; adequate physical habitat might lessen the ability of non-native fish and birds to harass and prey upon the native species.

Direct control of predation, whether avian or piscivorous, is not practical in any LCR MSCP reach at this time. It may be possible, however, to reduce predation rates by ensuring that fish are "conditioned" to predators and in the best possible physical condition when stocked. Additionally, the stocking practice used could also be refined. Currently (FY12 through FY15, with a possible extension), Work Tasks C10 and C11 are focused on techniques to "train" RASU and BONY to detect and appropriately avoid non-native fish predators.

Another possible way to improve survival is through releasing larger fish. Some preliminary data appear to indicate that fish released at or near 500 mm TL survive better than smaller fish, but the preliminary data indicate that survival for these larger fish is at the upper end of the range rather than hugely different from

that of smaller fish (survival of 500 mm TL fish ranges from 0.6 to 0.9%, while survival of fish released at 350 mm TL ranges from 0.26 to 0.85%). True differential in size-dependent survival has not yet been confirmed, nor has the presumed survival benefit been compared to the increased cost of raising larger fish. A full report on the initial stocking of 500 mm TL fish is currently being prepared and will be posted on the LCR MSCP Web site. Additionally, a report on survival estimates for fish released into Reach 3 is also currently being prepared. Regardless of differential survival exhibited by larger fish, rearing BONY and RASU to 500 mm TL is near the realistic limit of the current hatcheries due to of space limitations. Therefore, although early indications point to better survival by 500 mm TL fish, the practical limitations of raising large numbers of large fish mandate exploring other possible ways to improve survival either in concert with, or in place of, larger size at stocking.

It is possible that releasing fish that are smaller than 500 mm TL, but are in better physical condition and have been exercised or "conditioned," may also increase survival. Preliminary results of research conducted under Work Task C26 has begun to show promising results in improving the physical condition of RASU that spend the last portion of their time in a hatchery environment in moving water. The fish grew more rapidly and converted food to body mass more efficiently than fish that remained in static or near-static raceways. A final report documenting the presumed advantages to fish condition realized by such a program, *Final Evaluation of Flow Conditioning Razorback Sucker (Xyrauchen texanus) in Flow-Through Raceways at Lake Mead Fish Hatchery*, was prepared under Work Task C26, Evaluation of Raceway Rearing of Razorback Sucker at Lake Mead Fish Hatchery and will be posted on the LCR MSCP Web site. Future efforts will continue on this approach to rear fish in better physical condition with efforts to increase the numbers of fish that can undergo this "conditioning" regime and eventually to tag enough fish to determine if the improvements in conditioning translate to better survival in the wild.

The other major research priority for the fish augmentation program is the need to re-examine stocking practices. Currently, fish are loaded into trucks at various hatcheries and driven to locations along the river where they are either stocked or placed in tanks on small boats for transportation to lakeside rearing ponds (Lake Mohave). Mortality from stocking practices can originate from overly stressed fish or releasing fish at times or in areas where they are exposed to large numbers of predators before they become fully acclimated to their new environment. Work Task C46, Physiological Response in BONY and RASU to Transport Stress, has, and is continuing to examine, the physiological stress response of BONY and RASU to transport and stocking. Preliminary results indicate that there is no stress "bottleneck" or single step in the stocking process that is responsible for a majority of the stress response stocked fish experience.

Focus is therefore going to shift to examining the effect of how and when fish are stocked. Future research will concentrate on determining if stocking at particular times (e.g., night or crepuscular periods) leads to increased survival. Likewise, attempts will be made to determine if stocking at particular locations or stocking smaller numbers of fish also have an impact on survival.

All BONY and RASU studies in the river continue to be hampered by very low survival rates, which in turn make it difficult to re-contact the fish. This low survival/re-contact rate also leads to the relatively large error bounds often developed in growth and population estimates. In order to develop survival and population estimates with tighter error bounds, a prohibitively large number of fish would be required given the low survival rate. This need for extraordinarily large numbers of fish, combined with the amount of time required to detect and confirm trends, continue to hinder efforts in support of improving survival in the fish augmentation program.

In order to meet fish augmentation goals and to bolster the amount of data from released fish, it was planned during the development of the LCR MSCP to release approximately 10% of the overall fish augmentation goal during a roughly 5-year period of "accelerated stocking." The last 5-year monitoring and research priority plan identified the years from 2011 through 2016 as the "accelerated stocking" period. However, because of the extremely low survival experienced by BONY and RASU in almost all reaches of the LCR MSCP planning area, the decision was made to postpone the accelerated release period until 2014 or 2016, hoping that survival would improve. Elevated survival would be beneficial in terms of increasing the number of endangered fish in the water and also in increasing programmatic knowledge, enabling future managers to make more informed decisions. As of 2012, there has been no evidence of substantially improved survival from stocking larger fish or from any other effort/management decision on the LCR MSCP.

Undertaking the accelerated stocking program without a well-developed monitoring plan in place is thought to be a waste of time, effort, and fish. In addition to developing an adequate monitoring plan, it is now felt that every available effort should be made to release fish that are optimized for survival. Simply releasing larger numbers of fish, even larger fish, as done in the past will likely result in the same low survival rate very little knowledge will be gained from the exercise. The next logical step toward implementing the accelerated stocking program is to determine how to best increase the chance of survival for stocked fish, which is likely to include producing fish utilizing a number of the research priorities previously identified. If increasing survival to some acceptable level is possible, it will most probably be the result of stocking fish at optimal times and in optimal locations. Additionally, the stocked fish will likely need to be (1) larger than the original LCR MSCP fish augmentation goal of 300 mm TL

(probably much closer to 500 mm TL), (2) possibly be trained to identify and avoid predators, and (3) have the best possible body condition factor, which may only be attained through a regime of "exercise."

All of the research priorities discussed that might increase survival to the point that would make accelerated stocking beneficial need further development. Raising fish to 500 mm TL can currently be accomplished due largely to previous rearing practices research. However, developing a robust and meaningful monitoring plan, ascertaining the benefit of predator identification and avoidance training, determining the exact benefit of conditioned fish, and developing methods to utilize all of these techniques at a scale that would actually supply large numbers of fish is going to take several years to accomplish. Because of the scope of the work that still needs to be done to adequately vet and then actually put in place all the measures that might lead to better survival, the LCR MSCP Fisheries Group hopes to be in a position to begin the augmented stocking starting in 2018 or 2019.

In order to ensure that progress is being made toward the augmented stocking, a short update report will be produced by January 31 of each year until the augmented stocking begins. This report will pull together the annual reports for the projects designated as priorities in this document (i.e., fish conditioning, predator identification and avoidance, and examination of stocking practices) and will include a general summary of the number and size of fish that are currently being reared in hatcheries for the program. It is expected that this short report will assist in guiding and accelerating progress toward not just the augmented stocking but also improve survival.

Fish Species Research

Accomplishments 2008–2012

The most notable research activities for fish prior to 2012 were focused on post-stocking survival. Unfortunately, the results of several studies under Work Tasks C12, Demographics and Post-Stocking Survival of Repatriated Razorback Suckers in Lake Mohave; C33, Comparative Survival of 500-mm Razorback Sucker Released in Reach 3; and C39, Post-Stocking Distribution and Survival of Bonytail in Reach 3 have shown that survival of both BONY and RASU is low. Survival of RASU has been lower than 1%, while BONY survival estimates are still under development. There are several factors that have been investigated that most likely contributed to poor survival of these fish. Size at stocking seems to be important. A strong correlation between size at stocking and first-year survival was thought to exist, and targets for size at release have increased almost every year. While researchers are still hopeful that stocking larger fish will significantly increase survival, the relationship between size at stocking and survival does not appear to be linear, as fish stocked at 500 mm or larger have not survived as well as expected.

Initial species-specific research during this timeframe was also focused on developing baseline water quality parameters for BONY and RASU life support. These studies, the years they were conducted, and the parameters examined are included in subsequent reports: *2008 – Salinity, RASU Eggs and Larvae (narrower range), Report – Salinity Tolerances for Egg and Larval Stages of Razorback Sucker; 2009 – DO, RASU eggs and larvae, Report – Dissolved Oxygen Tolerances for Egg and Larval Stages of Razorback Sucker; 2010 – pH, RASU eggs and larvae, Report – Effects of Elevated pH on Survival of Early Life Stage Razorback Sucker and Bonytail (combined with 2011 results – still in draft); and 2011 – pH, RASU and BONY fingerlings, Report – Effects of Elevated pH on Survival of Early Life Stage Razorback Sucker and Bonytail* (2010/2011 report – in draft). Some minimum and maximum water quality parameter values required to support life have been established, and work is continuing to further quantify the required water quality parameters.

The potential for learning more about the food availability for BONY and RASU was researched under Work Task C34, Characterization of Zooplankton Communities in Off-channel Native Fish Habitats, beginning in 2009. This work involved monitoring lakeside rearing ponds on Lake Mohave for the plankton food base. A final report, *Characterization of Zooplankton Communities in Off-Channel Native Fish Habitat*, summarized the fact that the lakeside rearing ponds appeared to be depauperate of the types and sizes of large-bodied zooplankters that the literature suggests are the best food sources for RASU. Additionally, Work Task C44, Management of Fish Food Resources in Off-channel Native Fish Habitats, was initiated in 2011 to begin research into manipulating backwater habitat plankton communities via fertilization.

Multiple species-specific physical habitat requirement and preference studies were conducted between 2008 and 2012 under a variety of Work Tasks. Work Task C15, Flannelmouth Sucker Habitat Use, Preference and Recruitment Downstream of Davis Dam, was conducted between 2005 and 2011 to investigate flannnelmouth sucker (FLSU) habitat use below Davis Dam. These studies resulted in a series of annual reports, *Investigations of Flannelmouth Sucker Habitat Use, Preference and Recruitment Downstream of Davis Dam (2007, 2008, and 2009)* and a final, comprehensive report is currently being drafted. Initial data indicate that FLSU were rarely encountered below Needles, California, appeared to seek flowing water as opposed to slack water habitat, and were often encountered over cobble substrate at 1–2 meters (m) of depth. Efforts towards determining if artificial habitat could be added to sections of the river, particularly Lake Havasu, began under Work Task C41, Role of Artificial Habitat in Survival of RASU and BONY, and are still underway. Artificial habitat does not appear to be attractive to or used by RASU, while some usage by BONY has been observed. However, preferences for specific types of artificial habitat have not been determined, and it is not clear whether artificial habitat is a net benefit to BONY.

Proposed 2013–2017

Species research will be conducted in accordance to the LCR MSCP HCP Section 5.11.2 and in accordance to the avoidance and minimization measures (AMM), monitoring and research measures (MRM), and species-specific conservation measures. Research will focus on filling data gaps needed to guide, through the adaptive management process, the design and implementation of conservation measures. These efforts will inform creation and management of restoration sites through the collection of basic life history data such as food habits, migration timing, and limiting biological factors to ensure the continued survival of the covered species. The LCR MSCP has and will continue to communicate with all of its partners' resource agencies and groups as well as fisheries programs in the Upper Colorado River to both share information and to ensure that duplicative efforts are not undertaken. In particular, the LCR MSCP will communicate with personnel involved in the Glen Canyon Dam Adaptive Management Program.

The fish species specific research priorities not covered by some facet of fish augmentation research continue to be survival studies and the determination of the exact water quality parameters needed to support life, growth, and reproduction of BONY and RASU. Work Task C32, Determination of Salinity, Temperature, and Oxygen Limits for Bonytail and Razorback Sucker, is devoted to determining what dissolved oxygen, pH, salinity, and temperature requirements these species have, particularly in the early life stages. This information is critically important in the design and management of disconnected backwaters. Further studies into how temperature may interact with other water quality parameters and affect the health of RASU are also likely to occur. It is also expected that water quality studies will be completed on BONY eggs and larvae to determine critical dissolved oxygen, temperature, pH, and salinity by 2015. It is likely that after BONY egg and larval studies have been completed, all species-specific research required to make informed decisions about water quality management in disconnected backwaters will be present and available.

Species-specific survival research will continue, increasingly focused on how rearing and stocking practices may influence survival. Additionally, research on how fish species interact with and use created physical habitat is also expected to continue. Specifically, it is unclear whether artificial habitat is a net positive for native fish. Research conducted under Work Task C41, Role of Artificial Habitat in Survival of RASU and BONY, has documented use by native fish species of artificial habitat, but it remains unclear how non-native predators might also be attracted to, or utilize, artificial structures. Multiple studies conducted in other regions of the country suggest that artificial habitat can, in some circumstances, simply concentrate prey species to the structure and therefore lead to increased predation rates, as predators can encounter more prey around the habitat. Specifically, the LCR MSCP's efforts will be to determine if there is an optimum cavity size that would allow native species to utilize the cover but also exclude non-natives. Likewise, new Work Task C58, Investigating Shoreline Habitat

Cover for BONY, will investigate the size of riprap and other forms of shoreline cover to determine if there is an optimum cover size or type for BONY in order to better define management guidelines in the future.

Fish System-Wide Monitoring

Accomplishments 2008–2012

Large-scale monitoring efforts were put in place for fish with the advent of the LCR MSCP. Specifically, Work Tasks D8, Razorback Sucker and Bonytail Stock Assessment; C13, Lake Mead Razorback Sucker Study; C12, Demographics and Post-Stocking Survival of Repatriated Razorback Suckers in Lake Mohave; C33, Comparative Survival of 500-mm Razorback Sucker Released in Reach 3; and C45, Ecology and Habitat Use of Stocked RASU in Reach 3, led to routine monitoring in Lake Mead, Lake Mohave, and the remainder of Reaches 2 and 3, respectively. Multiple reports detailing the monitoring of covered species in these areas have been completed, while others are in draft form. All completed reports are available on the LCR MSCP Web site or upon request. The latest RASU population estimates for the reaches in the program area are: Reach 1, 733–982 (FY11 annual report); Reaches 2–3, 411 (FY11 annual report); and Reach 3, 1,400. Insufficient data are currently available to construct a RASU population estimate for Reach 4. Likewise, not enough data exist to generate a population estimate for BONY in any reach of the river.

Long-term monitoring of the Lake Mead razorback sucker population has occurred annually since 2005. Monitoring primarily takes place during the spawning season and consists of larval fish collections, trammel netting, and sonic telemetry. Additional monitoring is conducted outside of the known spawning season, but is limited to monthly sonic telemetry for the purpose of identifying razorback sucker habitat use and movements. Fin ray sections are removed from all captured adult and subadult fish for the purpose of age determination, while additional capture information is used to determine average annual growth and to develop a population estimate. Since 2005, 408 razorback suckers have been captured through this effort.

Probably the single most important new development in system-wide monitoring during this period was the widespread development and deployment of remote sensing technology. Beginning in 2009, remote sensing antennas that could detect fish implanted with Passive Integrated Transponder (PIT) tags were deployed near known spawning locations in Lake Mohave above Willow Beach National Fish Hatchery. There have been significant improvements in remote sensing technology, both by LCR MSCP staff and by the industry and researchers at large, which has made this an integral part of system-wide monitoring for fish species in the region. Since those initial deployments, the numbers of fish contacted by the antennae have almost doubled in each subsequent year. Detailed information on the development of remote sensing technology in the program as

well as the numbers of fish contacted have been compiled in a series of Work Task Accomplishment Reports: 2009 – C23, *Evaluation of Remote Sensing Techniques for PIT-Tagged Fish*; 2010 and 2011 – C12, *Demographics and Post-Stocking Survival of Repatriated Razorback Suckers in Lake Mohave*; and 2012 – D8, *Razorback Sucker and Bonytail Stock Assessment*.

Proposed 2013–2017

System-wide monitoring will be conducted in accordance with the LCR MSCP HCP as described in Section 5.11.1. System-wide monitoring will collect data on existing populations and their habitats to determine covered species status, distribution, density, migration, productivity, and other ecologically important parameters. Ongoing monitoring of endangered species will continue. Data gaps identified will be filled by conducting monitoring activities directed toward covered species in which little information is known. As these gaps are filled, it is anticipated that system-wide monitoring will decrease during the latter years of LCR MSCP implementation.

System-wide monitoring of covered fish species will continue in all reaches of the planning area. Particular attention will be paid to areas where natural recruitment has been documented, or is thought to exist, as well as areas where stocked populations appear to be surviving at a higher rate than the entire river. There is some evidence of recruitment of RASU in Lake Mead near the Colorado River inflow as well as possibly some other areas such as Las Vegas Bay and the Virgin River inflow. The monitoring on Lake Mead will continue under Work Task D8, Razorback Sucker and Bonytail Stock Assessment. Although no recruitment has been observed, there have been multiple contacts with BONY near the mouth of the Bill Williams River on Lake Havasu. The monitoring on Lake Havasu near the Bill Williams River is also being conducted under Work Tasks D8 and C33, Comparative Survival of 500-mm Razorback Sucker Released in Reach 3. Monitoring the sites that seem to be experiencing success either in terms of possible recruitment, or at least higher survival, will focus not only on monitoring the fish but also on determining which environmental factors and habitat features may be contributing to any successes observed.

More remote sensing work is expected to be conducted in Reach 3 over the next 5 years. This increased monitoring of Reach 3 is vital before the accelerated stocking efforts can be undertaken if those efforts are to lead to more fish surviving in the river. If the increased monitoring confirms the very low survival rate suspected in the reach, and there are no plausible ways to mitigate that low survival, it may be necessary to alter the planned accelerated stocking to focus on placing additional fish in areas where they are expected to survive and simply continue stocking relatively low numbers of native species in Reach 3.

Fish Post-Development Monitoring

Accomplishments 2008–2012

Five-year priorities for monitoring restoration sites are similar for covered species that have conservation measures describing restoration goals. Prior to initiation of restoration projects, pre-development surveys will be conducted. After each restoration project or phase has been completed, post-development monitoring will occur for targeted covered species and their habitats. Species monitoring protocols will be similar to those used for system-wide monitoring when appropriate. Habitat models will be created and tested to more efficiently monitor pre- and post-development. Decision support tools will be developed for managing created habitats to ensure these habitats provide the required site characteristics for targeted covered species. Five-year post-development monitoring priorities include:

- Post-development monitoring for fish species was focused on three areas: Imperial Ponds, Big Bend, and Beal Lake. Monitoring in all these areas was focused on population dynamics in general as well as water quality and habitat use. The presence of non-native predators was also noted as appropriate. The results of this monitoring will be used through the adaptive management process to help make future management decisions and to take actions at the sites.

  Monitoring at Imperial Ponds included year-round observations of water quality; pond elevation relative to river stage; habitat use by fish; and fish population dynamics, including both covered native species and non-natives introduced via a variety of pathways. Post-development monitoring at Imperial Ponds revealed that the ponds were not performing as well as had been planned as a refuge area for native fish primarily because of introduced non-natives that appeared to prey on the native species. Possible water quality issues have also been cited as a reason for the relative lack of success at Imperial Ponds, although quantitative data on the water quality parameters do not support this hypothesis as the sole reason native fish have not thrived in the ponds. The results of several years of monitoring Imperial Ponds have been recorded in annual reports for Work Task C25 and are posted, or will be posted, on the LCR MSCP Web site. Additionally, a comprehensive report detailing the development of the ponds, as well as the pertinent monitoring data, is currently being prepared.

  Big Bend, a connected backwater near Laughlin, Nevada, was monitored seasonally for water quality, water chemistry, and fish usage, particularly usage by flannel mouth sucker (FLSU). Several FLSU have been contacted within the technical boundaries of the area and many more are typically encountered immediately outside the area in higher flow

conditions. Annual reports on the monitoring effort of this site have been prepared under Work Task F5, Post-development Monitoring of Fish Restoration Sites.

Beal Lake, on Havasu National Wildlife Refuge, was not developed for the LCR MSCP. It preceded the program and is currently monitored by the program under the auspices of the 1997 Biological Opinion. Year-round water quality, as well as monitoring of several fish stocking events of Beal Lake occurred between 2008 and 2012, Native fish stocked into Beal Lake have consistently declined very rapidly after stocking, and large numbers of non-native species seem to be present during all fish sampling efforts. The results of many years of monitoring at Beal Lake can be found in several annual reports under Work Task F5.

Proposed 2013–2017

Post-development monitoring will be conducted in accordance with the LCR MSCP HCP as described in Section 5.11.4. Five-year priorities for monitoring restoration sites are similar for covered species that have conservation measures describing restoration goals. Prior to initiation of restoration projects, pre-development surveys will be conducted. After each restoration project or phase has been completed, post-development monitoring will occur for targeted covered species and their habitats. Species monitoring protocols will be similar to those used for system-wide monitoring when appropriate. Habitat models will be created and tested to more efficiently monitor pre- and post-development. Support tools will be developed for managing created habitats to ensure these habitats provide the required site characteristics for targeted covered species. Because the LCR MSCP is a habitat-based program, presence/absence of covered species is not a requirement for determining success. However, information gained from the presence of targeted covered species will increase our ability to provide habitat requirements for these species.

Post-development monitoring for fish species will continue as it has at the Big Bend Conservation Area. Because FLSU appear to be utilizing the area as intended, the priority for monitoring this area will be to develop a long-term data set that can be referenced for both the development of other connected backwater habitats and also in the event that for some reason FLSU use of the area declines. Monitoring of Beal Lake will also continue, but may be expanded as new management options are explored. For instance, some researchers have questioned whether water or sediment chemistry or contamination might be a factor in the low survival of RASU planted stocked into Beal. Because of this concern and the very poor survival, at least a limited assay of water and sediment is planned, and if the results of that assay are unexpected or would suggest that water or sediment chemistry might be playing a role in the low survival, monitoring of the relevant chemical parameters would continue. Likewise, at a minimum, the current monitoring regime at Imperial Ponds will continue and

could be expanded depending on management decisions and in response to further site development (e.g., the construction of new wells or further secondary water filtration system). In all cases, water chemistry and population dynamics will remain the focus in all of the developed habitats, with additional monitoring utilized as appropriate and in concert with the LCR MSCP adaptive management protocols.

Fish Restoration Research

Accomplishments 2008–2012

Most of the created fish habitat research conducted between 2008 and 2012 focused on evaluating the created habitat at Imperial Ponds. This research included determining specific microhabitat preferences of both RASU and BONY in terms of shoreline habitat types. There appeared to be no observable preference displayed by RASU for any of the three shoreline habitat types present: riprap, mud shorelines, and hummocks. Unfortunately, the habitat structures installed for use by BONY were not utilized because by the time of installation, the BONY population was extirpated. In addition to substrate and physical cover, water quality parameters were monitored. The results of these studies are summarized in annual reports under Work Task C25, Imperial Ponds Native Fish Research.

The multiple incursions by non-native species into Imperial Ponds over the life of the ponds have complicated their management. Pond 1 was renovated in 2009 and, along with Pond 3, was renovated again in 2010. These renovations were not believed to have been completely successful, and the ponds experienced further non-native introductions subsequent to the last renovation. Additionally, the single well in place could not deliver the volume of water thought to be required to maintain water quality requirements in all six ponds, but pumping river water, even with the screen system, most probably led to the introduction of additional non-native larvae and eggs. An evaluation of sand filtration technology to allow the use of river water was conducted in 2011. Although the sand filter appeared to be successful in excluding non-native eggs and larvae, more extensive testing of this technology is required. Although preliminary data indicate that sand filters systems may exclude eggs and larvae, the ongoing operation and maintenance of a sand filter may not be practical at Imperial Ponds. A full report on the sand filter evaluation study was prepared, *Evaluation of a Secondary Filtration Technology for Nonnative Fish Exclusion at the Imperial Ponds, Imperial National Wildlife Refuge, Arizona,* and will be posted to the MSCP Web site.

Concurrent with the end of the sand filter evaluation study, a decision was made in 2011 to move all remaining native fish to Pond 1 and to cease water management in the other five ponds. This decision was based on the fact that there was no information available on water quality for any of the ponds in the absence of adding water to attempt to manage water quality parameters. In order

to make an informed decision on the best supplemental water delivery system (e.g., additional wells, sand filter, microscreen technology, etc.), determining how much supplemental water would be required was vital. Water quality monitoring in all the ponds is ongoing, and it is expected that observing how water quality deteriorates in the "unmanaged" ponds will drive what supplemental water delivery system is ultimately chosen. A preliminary review of the first data set developed during this observational period appears to indicate that the water quality in "unmanaged" Imperial Ponds did not deteriorate as much as expected. If this is the case, the existing well, or possibly the existing well along with one new well, may be able to provide enough water to meet the water quality needs of all six ponds and would eliminate the water delivery system as a vector for non-native fish introduction. A full, retrospective report on the development and subsequent history of Imperial Ponds, including the period between 2008 and 2012, is currently under development.

Proposed 2013–2017

Despite the efforts of the LCR MSCP and its partners, the created disconnected habitat at Imperial Ponds has not been as successful as had been intended. Efforts to make Imperial Ponds more productive as habitat for RASU and BONY will continue, with effort devoted to maintain water quality, water delivery, and the elimination of non-native species. However, because of the constant threat of, and serious negative impact from, non-native intrusion into created disconnected backwaters, a new model for future backwaters of this type has been developed.

Future disconnected backwaters will ideally be constructed above river elevation and fed by wells. Supplying the ponds via well water will significantly slow the introduction of non-native species as compared to utilizing river water. Constructing the ponds above river elevation will also eliminate subsurface intrusion of river water into the ponds, which has been found to significantly hinder efforts at complete renovation of ponds both at Imperial Ponds and at Beal Lake. Subsurface flow from the river into created backwaters means that there is a constant flow of untreated water, which dilutes the effectiveness of the chemicals used for renovation. Additionally, it is possible that, in the future, chemical renovation of ponds may be difficult or impossible to achieve due to new laws or regulations. By constructing the ponds above the river elevation, it should be possible to, in the event of non-native introductions, allow native species to return to the river simply by opening a valve and letting the pond drain via gravity to the river. However, perching future ponds above river elevation will require the ponds to be lined with plastic, cement, or some other non-permeable substrate to prevent water from soaking into the ground.

Because future disconnected backwaters are likely to be much more "engineered" than at Imperial Ponds, much of the research already conducted by the LCR MSCP will be highly relevant to their construction. In particular, the species research on water quality needs (C32, Determination of Salinity, Temperature,

and Oxygen Limits for Bonytail and Razorback Sucker), microhabitat preferences (C41, Role of Artificial Habitat in Survival of RASU and BONY; C49, Investigations of RASU and BONY Movements and Habitat Use Downstream of Parker Dam; C56, Characterization of Lake Mohave Backwaters to Evaluate Factors Influencing Spawning Success; and C58, Investigating Shoreline Habitat Cover for BONY) and food web manipulation (C44, Management of Fish Food Resources in Off-Channel Native Fish Habitats) will all be applicable as well as future Work Tasks that will be developed to build on the results of prior research and emerging management questions.

WILDLIFE RESEARCH AND MONITORING

The following section describes the LCR MSCP wildlife activities, including: research and monitoring for species, post-development monitoring, and restoration research. Information provided includes accomplishment of activities for FY08 through FY12. Information obtained through these activities has led to additional research and monitoring priorities listed as proposed activities for FY12 through FY17.

Species research was conducted in accordance to the LCR MSCP HCP as described in Section 5.11.2 and is in accordance with the AMM, MRM, and species-specific conservation measures. Research focused on filling data gaps needed to guide, through the adaptive management process, the design and implementation of conservation measures. These efforts inform creation and management of restoration sites through the collection of basic life history data such as food habits, migration timing, and the limiting biological factors to ensure the continued survival of the covered species.

System monitoring will be conducted in accordance with the LCR MSCP HCP as described in Section 5.11.1. System monitoring will include collecting data on existing populations and their habitats to determine covered species status, distribution, density, migration, productivity, and other ecologically important parameters. Ongoing monitoring of endangered species will continue, and productivity and survival of avian species will be continued through the use of the Monitor Avian Productivity and Survival (MAPS) stations. Data gaps identified will be filled by conducting monitoring activities directed toward covered species in which little information is known. As these gaps are filled, it is anticipated that system monitoring will decrease during the latter years of LCR MSCP implementation.

Marsh Birds

Species Research Accomplishments 2008–2012

Habitat requirements for the Yuma clapper rail were fairly well defined prior to 2008, so research priorities in 2008–2012 emphasized further defining habitat requirements for least bittern and California black rail.

- Further define habitat requirements for least bittern, especially minimum patch size and percent vegetation/open water considered ideal for this species. Conservation measures list minimum patch size for Yuma clapper rail and California black rail (5 acres); however, no minimum patch size has been determined for least bittern.

  This priority research has not yet been accomplished and will be moved to the next 5-year priority period.

- Design a habitat mosaic to provide the habitat requirements needed by all three marsh birds within one habitat block.

  A study entitled "Restoration of managed marsh units to benefit California black rails and other marsh birds: an adaptive management approach" was completed in May 2011 by Nadeau et al. (2011) (Work Task C24). This study recommended that a simple wetland design for future managed wetland impoundments would include three components: (1) an area with shallow and stable water depths at one end of the impoundment containing bulrush, (2) a gradual slope containing a mix of bulrush and cattail, and (3) an area with deep water to provide least bittern habitat needs. Habitat will be created in mosaics to provide species-specific habitat requirements for the three marsh birds where feasible.

Species Research Proposed 2013–2017

- This research priority is a continuing priority from the 2008–2012 list of priorities. Further define habitat requirement ranges for all three covered marsh bird species for management purposes. These requirements may include minimum patch size, water depth, vegetation cover, and percent vegetation/open (MRM1, LEBI1, CLRA1, and BLRA1).

- Establish protocols that may or may not already exist over a number of years and then monitor selenium in created backwaters and marshes. If monitoring indicates management of conservation areas increases levels of selenium in created backwaters and marshes, then conduct research to develop feasible methods to manage the conservation areas in a manner that will eliminate or compensate for the effects of increased selenium levels (MRM5).

System-Wide Monitoring Accomplishments 2008–2012

Yuma clapper rail surveys have been conducted along the lower Colorado River since the 1970s by an interagency group that includes Federal, State, and Tribal agencies. In anticipation of LCR MSCP implementation, a multi-species survey protocol was developed and tested. Implementation of the multi-species protocol began in 2006, including the Yuma clapper rail, least bittern, and California black rail, and it has been designed to include other species when appropriate. Five-year system monitoring priorities include:

- Continue the interagency marsh bird surveys, using the current multi-species protocol, at survey points done historically.

  LCR MSCP marsh bird surveys have been conducted within Topock Gorge annually since the 1980s and continue to be conducted since the beginning of the program in FY06 (Work Task D1). Surveys indicate that marsh bird populations continue to be stable.

- Determine whether new sites should be included in the system monitoring effort.

  Under Work Task D1, sites are reviewed each year to determine whether new sites should be added under this effort.

- Document black rail distribution in Reaches 5–6.

  Black rail distribution has been determined throughout the lower Colorado River (Work Task D1). Black rails have been documented throughout the region from Lake Mead down to the Southerly International Boundary. Because of this documentation, the conservation measure for this species has been updated through a minor modification at a Steering Committee meeting on October 27, 2011.

- Evaluate the current protocol to determine if the May survey period should be extended to increase least bittern detections

  This evaluation has not been completed and will be rolled over to the next 5-year priority period.

- Develop a protocol to monitor marsh habitats for covered species requirements such as prey abundance and selenium concentrations.

  This evaluation has not been completed and will be rolled over to the next 5-year priority period.

- Convert existing and historical data into a digital database.

  Existing and historical data are being entered into LCR MSCP's digital database and will continue during the next 5-year priority period.

- Provide training to new surveyor.

  All new surveyors have been trained specifically in the national multi-species marsh bird protocol.

System-Wide Monitoring Proposed 2013–2017

- Continue the interagency marsh bird surveys, using the current multi-species protocol, at historical survey points in order to estimate population trends over time.

- This monitoring priority is a continuing priority from the 2008–2012 list of priorities. Evaluate the current survey protocol to determine if the survey period for marsh birds should continue to be conducted in the May survey period to increase least bittern detections. The most recent survey protocol calls for three separate survey periods ending April 30 (Conway 2011). Reclamation surveys have typically been conducted in May to increase bittern detections, but this has not been evaluated for effectiveness given the new guidelines.

- This monitoring priority is a continuing priority from the 2008–2012 list of priorities. Develop a protocol to monitor marsh habitats for covered species requirements such as prey abundance and selenium concentrations. Selenium monitoring is scheduled to begin in FY13.

- Evaluate the sampling design to ascertain if there is a statistical relationship between marsh birds (LEBI, CLRA, and BLRA) survey results (i.e., call playback surveys) and true population estimates.

Riparian Birds

Species Research Accomplishments 2008–2012

- Conduct studies on water needs for riparian birds within created habitats. Southwestern willow flycatchers (SWFL) require standing water or moist soils during the breeding season (Sogge and Marshall 2000; U.S. Fish and Wildlife Service [USFWS] 2002); however, it is unknown whether water is required throughout the entire habitat, what percent of the habitat must be wet to provide adequate habitat requirements for breeding, how long

into the breeding season water is required, and when habitat needs to provide these moist soil characteristics to attract covered species. Some species, such as yellow-billed cuckoo (YBCU), may benefit from moist soils; however, data are not currently known.

A study entitled "Soil Hydrology and Microclimate Conditions in Occupied Southwestern Willow Flycatcher and Yellow-Billed Cuckoo Habitat" was completed February 29, 2012 (Balluff 2012) (Work Task C37). This report documented a range of soil hydrology and microclimate conditions and indicated that there were significant differences in conditions between SWFL and YBCU occupied habitats. Statistical tests indicated that YBCU sites had lower percent soil moisture, sandier soil texture, less area of standing water, greater depth to groundwater, and greater distance to flowing water compared with SWFL sites. YBCU can occupy areas with a broader range of soil moisture and standing water than the SWFL such as they can occupy areas containing little to no soil moisture up to areas containing standing water. This study also identified depth to groundwater, soil texture, and distance to flowing water as the most important variables distinguishing SWFL from YBCU habitats.

The results suggest that creation or restoration of habitat for SWFLs should occur under different soil hydrology and microclimate conditions and in different locations than creation or restoration of habitat for YBCUs. It is recommended that soil texture be analyzed when evaluating potential creation or restoration sites for these species. For the SWFL, the sites used tended to be less sandy, with moderate soil moisture, large areas of standing water, and within 200 feet of flowing water. This was consistent with the conclusions of previous research that indicate SWFLs require surface water or saturated soil conditions to breed (Ellis et al. 2008; Paxton et al. 2007; Sogge and Marshall 2000; U.S. Forest Service 2000; USFWS 2010).

Future research should address soil moisture unit standardization such as terminology, differences between surface water, saturated and wet soils, soil moisture range for SWFL, and acres to be managed. Studies should provide numbers for these qualitative statements to allow restoration sites to be constructed and managed for the habitat parameters that are required by the species.

- Define habitat requirements and limiting factors for covered species and initiate studies to define habitat requirements in which existing information is limited. Use these data to develop models that determine ideal habitat characteristics and habitat mosaics at the site and landscape levels. Data gathered through existing monitoring and research will be

used to develop initial habitat suitability index models for covered species. As additional data are accumulated, models will be re-evaluated. Specific habitat requirement data need may include:

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    - Acquiring microhabitat requirement data for breeding covered species so that threshold ranges can be estimated
    - Delineating required breeding habitat conditions for YBCU and Bell's vireo along the LCR
    - Researching necessary breeding habitat requirements for vermillion flycatcher, including optimal tree density, shrub density, and herbaceous plant effects
    - Researching necessary breeding habitat requirements for summer tanager, including minimum patch size and canopy closure

Habitat for several riparian bird species has been initiated in conjunction with system-wide general bird surveys, including the Sonoran yellow warbler, Arizona Bell's vireo, summer tanager, and Gila woodpecker (Work Tasks C24 and D6). Basic habitat associations were completed for these four species and can be found in "Summary Report on the Lower Colorado River Riparian Bird Surveys, 2008–2010" (Great Basin Bird Observatory [GBBO] 2010). Preliminary results indicate that Bell's vireo territories were placed in sites that had significantly less upland vegetation, more large trees, more cottonwood trees and mesquite, and greater canopy cover than non-use sites. Gila woodpeckers were found in habitats with nearby surface water and containing more large trees and snags, more willows, and more mistletoe infestations than non-use sites. Summer tanager territories were located in sites that had less upland vegetation, more large trees, more saltcedar, more willow, more cottonwood trees, and greater canopy cover than did non-use sites. Yellow warbler territories were located in sites that had less upland vegetation, more large trees, more cottonwood trees, less mesquite, but more willows and greater canopy cover than did non-use sites. These habitat associations will be further refined during the next 5-year priority period.

Habitat studies for the SWFL have been completed under the presence/absence and life history studies for the SWFL (Work Task D2.) A summary and findings of these studies can be found in the report "Southwestern Willow Flycatcher Surveys, Demography, and Ecology along The Lower Colorado River and Tributaries, 2003–2007" (McLeod et al. 2008). When all study areas were combined, SWFLs exhibited nest-site selection for habitat that was cooler during the day, more humid overall, exhibited greater soil moisture, and experienced a smaller daily temperature range than unoccupied riparian habitat. This general pattern

was consistent throughout the nesting season. The most important microclimate variables separating nest site and unoccupied habitat were mean daily temperature range and mean nocturnal vapor pressure when all study areas were combined, with nest site habitat associated with a more moderate thermal regime. In these study areas, SWFLs select nesting habitat that buffers diurnal heat gain and nocturnal heat loss. Specific management recommendations for nesting habitat included increasing canopy height, canopy closure, soil moisture, and density within the stand.

Habitat studies for the YBCU have been initiated under the "Yellow-billed Cuckoo Distribution, Abundance and Habitat Use on the Lower Colorado River and Tributaries" (Work Task D7) (McNeil et al. 2012). The first 5 years of data are still being analyzed.

A specific YBCU Geographic Information Systems based habitat model was developed by the U.S. Geological Survey (USGS) (Work Task C24) based on known YBCU populations in the Bill Williams River National Wildlife Refuge and Lake Mead inflow (Johnson et al. 2012). There are several important features associated with cuckoo breeding habitat. An area of dense cottonwood-willow within a 120-m radius (4.5 hectares [ha]) of a location increased the chances of cuckoo occurrence. Also, the likelihood of cuckoo occurrence continued to increase if the core area was surrounded by a large, native forest (480 m radius/72 ha) that contained lots of structural diversity. Cuckoos were negatively associated with habitat fragmentation and small patch size. This model will be adjusted based on occupied LCR MSCP restoration areas in the next 5-year priority period.

Breeding habitat requirements for vermillion flycatcher and gilded flicker are planned (Work Tasks C51 and C52) and will be rolled into the next 5-year priority period.

An elf owl (ELOW) detectability study was conducted from 2009 through 2011 to develop a long-term ELOW plan for the LCR MSCP (Work Task C36) (GBBO 2012). A detailed recommendation was provided for a standardized LCR MSCP ELOW discovery survey protocol. This protocol will be used to conduct ELOW system-wide and post-restoration surveys.

A study to determine the effects of nest predation on susceptible bird species such as the SWFL, yellow warbler, and Arizona Bell's vireo was conducted from 2009 through 2011 (Work Task C28) (Theimer et al. 2010). This study showed the main predation of open cup nesters included avian species such as yellow-breasted chats and brown-headed cowbirds; mammal species, including rodents such as mice and rat species; and snake species. Management recommendations include shortening the distance to

standing water to reduce parent feeding times away from nest, increase hiding cover in the first 3-meter layer, and increasing the total amount of habitat availability.

Species Research Proposed 2013–2017

Southwestern Willow Flycatcher

- Further refine and standardize soil moisture units, such as terminology, differences between surface water, saturated and wet soils, soil moisture range for SWFL, and acres to be managed. Studies would provide ranges for these qualitative statements to allow restoration sites to be constructed and managed for the habitat parameters that are required by the species.

- Assess the hydrology at restoration sites and then, if necessary, conduct hydrology studies/demonstrations to determine the appropriate water regime for breeding SWFL habitat. Varying irrigation regimes will be tested to determine the appropriate regime to create and/or maintain breeding flycatcher habitat (MRM1, MRM2, and WIFL1).

Yellow-billed Cuckoo

- Assess and compare the diversity and abundance of prey base at created sites and other nesting sites in order to fill a life history data gap (MRM1, MRM2, YBCU1, and YBCU2).

Vermilion Flycatcher

- Conduct population surveys to document all breeding populations of vermilion flycatcher in the LCR MSCP planning area. This will be completed in an atlas-type approach, not random sampling, in order to get comprehensive coverage (AMM1, AMM2, and MRM1).

- Conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of vermilion flycatcher habitat (MRM1 and VEFL1).

- Conduct winter habitat use studies for vermilion flycatcher as they are resident birds year round in the LCR (AMM1, AMM2, MRM1, and VEFL1).

Sonoran Yellow Warbler

- Continue to conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of the yellow warbler. Assessments are also currently being conducted as to whether microclimate is important for this species (MRM1, MRM2, and YWAR1).

- Evaluate the habitat models and use them to refine the management guidelines if necessary (MRM1, MRM2, and YWAR1).

Arizona Bell's Vireo

- Continue to conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of Bell's vireo. Assessments are also currently being conducted as to whether microclimate is important for this species. (MRM1, MRM2, and BEVI1).

- Evaluate the habitat models and use them to refine the management guidelines if necessary (MRM1, MRM2, and BEVI1).

Summer Tanager

- Continue to conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of summer tanager. Assessments are also currently being conducted as to whether microclimate is important for this species (MRM1, MRM2, and SUTA1).

- Evaluate the habitat models and use them to refine the management guidelines if necessary (MRM1, MRM2, and SUTA1).

Elf Owl

- Conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of the ELOW (MRM1 and ELOW1).

- Evaluate the effectiveness of ELOW nest boxes within created habitats (MRM2 and ELOW2).

- Determine breeding habitat selection for ELOW within cottonwood-willow and honey mesquite land cover types (MRM1 and ELOW1).

- Evaluate interspecific competition for nest sites between ELOW and European starlings (MRM3).

Gilded Flicker

- Conduct surveys to define initial distribution and population estimates along the LCR and refine a survey protocol. Little is known regarding the status, distribution and habitat use of this species along the LCR (AMM1, AMM3, MRM1, and GIFL1).

- Conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of gilded flicker (MRM1 and GIFL1).

- Conduct artificial snags or nesting structure research to determine the best way to provide artificial nesting structures for this species (GIFL2).

- Conduct studies on winter distribution and seasonal movement. Gilded flickers are nonmigratory and winter along the LCR. From the little observational data conducted, the flickers may be using the riparian habitat after they breed in the winter instead of during the breeding season (MRM1 and GIFL1).

Gila Woodpecker

- Conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of the Gila woodpecker. Assessments continue as to whether microclimate is important for this species (MRM1, MRM2, and GIWO1).

- Conduct a study on artificial snags and nest box structures to determine the best way to provide artificial nesting structures for this species (GIWO2).

- Conduct a winter distribution, seasonal movement, and habitat use study. Gila woodpeckers are nonmigratory and utilize the habitat along the LCR after they breed. Late winter habitat may also be important to them as they choose their nesting sites during the winter season (MRM1, MRM2, and GIWO1).

General Birds

- Evaluate the need for additional heterogeneity such as herbaceous cover, different age structure of trees, additional shrub layer, and/or open water/marsh component within restoration sites (MRM1 and MRM2).

- Conduct research to determine and address the effects of nest site competition with European starlings on cavity nesting species (MRM3).

System-Wide Monitoring Accomplishments 2008–2012

System monitoring for riparian birds has been conducted using single species or multi-species protocols depending on purpose and need. SWFL presence/absence surveys have been conducted on an annual basis since 1996, utilizing a 10-visit protocol adapted from the USFWS-approved protocol by San Bernardino County Museum (McKernan and Braden 2001). In 2008, a new, modified survey protocol will be conducted after input from species experts. In 2006, system monitoring for YBCU was initiated using a presence/absence protocol developed jointly by USGS and Southern Sierra Research Station (Johnson et al. 2005). Species experts have provided input on the YBCU protocol so that a standardized protocol would be in place by 2008.

SWFL and YBCU surveys will help determine status and trend for these important umbrella species. System monitoring for the other covered avian species will be conducted using multi-species protocols (GBBO 2003; Bart 2007). Population status, distribution, and trend will be monitored for gilded flicker, Gila woodpecker, vermilion flycatcher, Arizona Bell's vireo, yellow warbler, and summer tanager. An additional methodology needs to be established for ELOW along the LCR, as these birds are nocturnal.

Five-year system monitoring priorities are based on current knowledge of status, distribution, trend, and demography for each covered species. These 5-year priorities include:

- Monitoring 372 acres of SWFL habitat between Parker and Imperial Dams to meet commitments in the Secretarial Implementation Agreement Biological Opinion.

  SWFL habitat between the Parker and Imperial Dams has been monitored since 2004 (Work Task D3). This monitoring effort has found that the interannual changes in soil moisture in 2005–2006, 2007–2008, and 2009–2010 were not similar between test and control sites, with soil moisture declining more sharply at the control sites during the first two periods and then rising sharply during the third. This suggests that local conditions, in addition to regional climate, may have influenced soil moisture, and regional weather appears to have an overriding influence on humidity

within both test and the control sites. There also has been no correlation in vegetation differences with groundwater and thus river level fluctuations; thus, it has been recommended to USFWS that these studies be discontinued.

- Evaluating the protocol to determine the need for annual surveys at all sites for SWFL and YBCU.

  The data have been evaluated for all survey sites for the SWFL since 1996 (Work Task D2). This evaluation indicates that annual surveys are not needed for habitat below Parker Dam due to no confirmed nests being located at any of these survey sites since the beginning of the surveys. These sites will continue to be surveyed on a 3-year rotating basis. Not enough data have yet been collected to determine the need for annual surveys for YBCU. This will be completed in the next 5-year priority period.

- Developing monitoring protocol for ELOWs and determining population status and distribution within the LCR MSCP area.

  A monitoring protocol has been developed for ELOWs in 2011 and 2012 (Work Task C36). This survey protocol will be used in system-wide ELOW surveys to determine population status and distribution within the LCR MSCP area beginning in FY13 (Work Task D13).

- Monitoring population status and distribution for Gila woodpecker, gilded flicker, vermilion flycatcher, Arizona Bell's vireo, yellow warbler, and summer tanager within LCR MSCP area.

  Population status and distribution have been monitored and will continue to be monitored through both the MAPS (Work Task D5) and through system monitoring for riparian obligate avian species (Work Task D6). Population distribution and baseline abundance has been established for Gila woodpecker, vermillion flycatcher, Arizona Bell's vireo, yellow warbler, and summer tanager utilizing 2007–2010 data. The gilded flicker numbers are very low, and abundance and distribution cannot yet be determined for this species. Monitoring efforts will continue throughout the next 5-year priority period to determine trends for these species.

- Developing habitat suitability index models for riparian obligate birds to quantify potential habitat.

  Habitat suitability index models have been broadly developed for the Arizona Bell's vireo, yellow warbler, summer tanager, and Gila

woodpecker (Work Task D6 and C24). These models will be updated with additional, more detailed information as needed over the next 5-year priority period.

- Monitoring winter habitat use for vermilion flycatcher.

  This priority monitoring has not yet been accomplished and will be moved to the next 5-year priority period.

System-Wide Monitoring Proposed 2013–2017

System-wide monitoring for riparian birds has been conducted using single species or multi-species protocols depending on purpose and need. SWFL presence/ absence surveys have been conducted on an annual basis since 1996, utilizing a slightly modified version of the USFWS approved protocols. In 2006, system-wide monitoring for YBCU was initiated using a presence/absence protocol developed jointly by USGS and Southern Sierra Research Station (Johnson et al. 2005). SWFL and YBCU surveys will help determine status and trends for these important umbrella species.

System-wide monitoring for the other covered avian species is being conducted using multi-species protocols (GBBO 2003; Bart 2007). Population status, distribution, and trends will be monitored for gilded flicker, Gila woodpecker, vermilion flycatcher, Arizona Bell's vireo, yellow warbler, and summer tanager. A system-wide protocol has been developed for the ELOW and will be initiated in FY13.

Five-year system monitoring priorities are based on current knowledge of status, distribution, trend, and demography for each covered species. These 5-year priorities include:

- Continuing system-wide presence/absence surveys for the SWFL. All presently known breeding sites will be surveyed every year. Sites below Parker Dam will be surveyed on a rotational basis every 3 years.

- Continuing system-wide presence/absence surveys for the YBCU. All presently known breeding sites will be surveyed every year. Other sites will be surveyed on a rotational basis.

- Continuing to monitor population status and distribution for Gila woodpecker, gilded flicker, vermilion flycatcher, Arizona Bell's vireo, yellow warbler, and summer tanager within the LCR MSCP area, utilizing either species-specific protocols or general bird system-wide surveys.

- This monitoring priority is a continuing priority from the 2008–2012 list of priorities. Monitoring winter habitat use for vermilion flycatcher.

Bats

Species Research Accomplishments 2008–2012

- Initiate studies to categorize roosting habitat requirements, especially habitat level vegetation requirements such as patch size, canopy closure, species requirements, and mosaic. Data collected during monitoring activities may be used to help describe roosting requirements.

  A western red and western yellow bat roosting study was initiated in 2011 (Work Task C35). This study will determine roosting location and habitat requirements for these two species. This study is anticipated to be finalized in 2013.

  A study on the population demographics and habitat use of the California leaf-nosed bat was initiated in 2011(Work Task C43). This study will determine the population genetic history of the California leaf-nosed bats along the LCR and identify which roosts foraging leaf-nosed bats in habitat conservation areas originated. This will help clarify the distance of roosting to foraging habitat in order to prioritize the location of created foraging habitat for this species. This study is anticipated to be finalized during the next 5-year priority period.

- Initiate studies to categorize foraging habitat requirements, including prey abundance.

  A western red and western yellow bat roosting study was initiated in 2011. This study will determine roosting location and habitat requirements for these two species. This study is anticipated to be finalized in 2013. Prey abundance studies at restoration sites will begin in 2013 and continue during the next 5-year priority period.

Species Research Proposed 2013–2017

- Finalize breeding and roosting habitat study for red and yellow bats. Characteristics include canopy cover, density, distance to open water, roost tree preference, foliage density, and microclimate (MRM1, MRM2, WRBA2, WYBA2, and WYBA3).

- Conduct research to define habitat use, timing and location of use, and appropriate range of parameters for creation and management of red and yellow bats.

- Initiate a distance from roost to foraging habitat for the California leaf-nosed bat and the Townsends big-eared bat. The HCP calls for habitat to be created within 5 miles of known roosts if possible for these species, but more data are needed to evaluate whether these species are limited to a 5-mile foraging range (CLNB1, CLNB2, PTBB1, and PTBB2).

System-Wide Monitoring Accomplishments 2008–2012

System-wide monitoring for all bats species found along the LCR has been conducted using an established protocol (Brown 2006). Distribution and relative abundance will be measured throughout the year on a seasonal basis. Five-year system monitoring priorities include:

- Monitoring distribution and abundance of red and yellow bats along the LCR.

  Distribution and abundance of all four LCR MSCP bat species have been monitored through acoustic surveys, mine outflight counts, and mistnetting efforts (Work Task D9). Surveys indicate that, at present, the distribution of western red bats and western yellow bats are limited within the LCR MSCP project area. The viability of western red bats and western yellow bats along the LCR is dependent on the availability of cottonwood-willow habitat, although western yellow bats will likely benefit from the establishment of native mesquite bosques as well. Occupancy models were created for all four LCR MSCP bat species. These models showed that high occupancy can be achieved through conversion of only a small percentage of saltcedar to cottonwood-willow. Monitoring will continue during the next 5-year priority period in order to track distribution and abundance trends.

- Recording all bat species during acoustical surveys so that possible surrogate species may be monitored for distribution and abundance.

  Acoustic surveys have been completed for all bat species beginning in 2006. Permanent Anabats have been set up in strategic locations throughout the LCR. These permanent stations record bat acoustic calls every night throughout the year and are analyzed on a yearly basis. For all species combined, activity was significantly higher at the Imperial and Bill Williams stations than at the Cibola, Picacho, and Mittry stations. Activity was significantly higher during the summer, followed by spring, fall, and winter. Variances of mean call minutes for the focal species and total species were generally lowest in the summer and highest in fall and winter. These permananent stations continue to run, and data will be analyzed to track trends in distribution and abundance through the next 5-year priority period.

- Determining the distance from urban areas and fan palm trees for any yellow bats detected.

  It has been determined that this is not a priority.

System-Wide Monitoring Proposed 2013–2017

Post-development monitoring for all bats species found along the LCR has been conducted using the same protocols for the system-wide surveys. Distribution and relative abundance will be measured throughout the year on a seasonal basis. Five-year system monitoring priorities include:

- Continuing to monitor distribution and abundance of red and yellow bats along the LCR in order to track distribution and long-term trends in populations.

- Recording all bat species during acoustical surveys utilizing long-term bat stations so that possible surrogate species may be monitored for long-term trends in distribution and abundance of covered bat species.

- Continuing to conduct out-flight counts of California leaf-nosed and Townsends big-eared bats to evaluate long-term trends in distribution and abundance.

Small Mammals

Species Research Accomplishments 2008–2012

- Evaluate the genetic differences between Yuma hispid cotton rat and other hispid cotton rats found in southeastern Arizona. The Yuma hispid cotton rat may be a highly differentiated subspecies with a unique life history and habitat characteristics that differ from the main population of hispid cotton rats.

  Existing information from the southeastern Arizona subspecies, when combined with data acquired along the LCR, will provide for restoration and maintenance.

  A study entitled "Diagnosis, Distribution, and Habitat Attributes of Two LCR MSCP Covered Species: The Colorado River (Sigmodon Arizonae Plenus) and Yuma Hispid (Sigmodon Hispidus Eremicus) Cotton Rats" was completed in 2010 (Work Task C27). This study used a molecular genetics approach to determine (1) a method of species-level taxonomic diagnosis from field trapped and released specimens, (2) an assessment of current species distributions (both current and potentially in contrast to

distributions about a century ago) within the area covered by the LCR MSCP, and (3) an understanding of the population structure within each of the two species in order to properly choose populations to draw upon for relocation efforts. Results indicate the two species have not been found together along the river in any study to date or in the intervening areas of approximately 30 miles (47 kilometers [km]) between the northernmost known populations of Yuma cotton rat and southernmost Colorado River cotton rat. This indicates there is a distinct geographical break between these two populations. There is also significant genetic evidence to distinguish these two as separate species/subspecies. There is some indication of a boom-bust population structure cycle of these two species. Finally, relocation is probably not necessary for either of the Sigmodon species, as there are populations distributed across the LCR, and this species appears to readily colonize newly developed habitat (e.g., Cibola Nature Trail).

- Initiate research to describe habitat requirements for Colorado River cotton rat in both marsh and cottonwood-willow habitats, including limiting factors influencing habitat use or selection. Additional benefits for this species may be obtained by managing some cottonwood-willow restoration sites for dense herbaceous and grass cover.

  A study entitled "Modeling microhabitat and survival estimates of Sigmodon arizonae plenus along the lower Colorado River" was initiated in 2010 to determine the habitat needs of the Colorado River cotton rat (Work Task C27). Surveys and data collection are still being conducted, and results will be available in 2013.

- Initiate research to describe habitat requirements for Yuma hispid cotton rat, including limiting factors influencing habitat use or selection.

  A large enough population of this species has not been located. Continued efforts to locate larger populations and determine habitat requirements will begin during the next 5-year priority period.

Species Research Proposed 2013–2017

- Finalize research to describe habitat requirements for Colorado River cotton rat in both marsh and cottonwood-willow habitats, including limiting factors influencing habitat use or selection, patch size, vegetative cover, vegetation composition, microclimate conditions, and distance to standing water (MRM2, CRCR1, and CRCR2).

- Initiate research to describe habitat requirements for Yuma hispid cotton rat. These may include factors influencing habitat use or selection, patch size, vegetative cover, vegetation composition, microclimate conditions, and distance to standing water (MRM2, YHCR1, and YHCR2).

System-Wide Monitoring Accomplishments 2008–2012

Presence/absence surveys have been conducted on riparian restoration demonstration sites and at restoration sites along the LCR. Current distribution and range for the Colorado River cotton rat and Yuma hispid cotton rat are assumed from existing literature. It is unknown whether these two species' distributions overlap. Because these species cannot be adequately determined in the field, genetic material will need to be taken from captured individuals to determine range restrictions. Five-year system monitoring priorities include:

- Delineating distribution and range for Colorado River cotton rat and Yuma hispid cotton rat after genetic studies have been completed

  Preliminary surveys have been conducted along the lower Colorado River in conjunction with the genetic studies. Results indicate the two species have not been found together along the river in any study to date or in the intervening areas of approximately 30 miles (47 km) between the northernmost known populations of Yuma cotton rat and southernmost Colorado River cotton rat. This indicates there is a distinct geographical break between these two populations. There is also significant genetic evidence to distinguish these two as separate species/subspecies. The full effort will begin in FY13 (Work Task D10) and will be rolled over to the next 5-year priority period.

- Developing habitat suitability index model to quantify potential habitat if practical.

  Habitat suitability index model data are being collected and will be completed in 2013 for the Colorado River cotton rat (Work Tasks C27 and D10). Additional populations for the Yuma hispid cotton rat need to be located to gather enough data for a model for this species. Data will continue to be collected, and the model will be finalized during the next 5-year priority period.

- The southerly distribution limits for the desert pocket mouse are assumed to be near Laughlin, Nevada. Pocket mice caught near Needles will be sampled to test this assumption.

  It has been determined that this is not a priority.

System-Wide Monitoring Proposed 2013–2017

Presence/absence surveys have been conducted on riparian restoration demonstration sites and at restoration sites along the LCR. Current distribution and range for the Colorado River cotton rat and Yuma hispid cotton rat are assumed from existing literature. It is unknown whether these two species' distributions overlap. Because these species cannot be adequately determined in the field, genetic material will need to be taken from captured individuals to determine range restrictions. Five-year system monitoring priorities include:

- Conducting surveys to evaluate distribution and range for Colorado River cotton rat and Yuma hispid cotton rat to determine population trends and separation of populations of these two species.

Insects

The LCR MSCP has one covered insect, the MacNeill's sootywing skipper. Several other covered species such as the neotropical migrant birds and bats utilize insects for prey. This section includes both research and monitoring for the MacNeill's sootywing and studies specific to prey base for the other covered species.

Species Research Accomplishments 2008–2012

- Acquire additional information on Macneill's sootywing habitat requirements, including microhabitat characteristics such as soil moisture, soil salinity, soil nitrogen, and plant water content.

  A study entitled "Survey and Habitat Characterization for Macneill's Sootywing" was completed in 2008 (Work Task C7). This study indicates that Sootywings require large Atriplex with high water content during the active breeding season, and nectaring plants consist of heliotrope, sea purslane, and mesquite.

- Design habitat mosaic including quailbush, nectar-producing plants, and mesquite for Macneill's sootywing.

  Cibola Valley Conservation Area Phases 4 and 5 and Palo Verde Ecological Reserve Phase 5 were specifically created in a habitat mosaic of these plant species. Sootywing use has been found in these phases. Additional habitat will be modeled after this mosaic. Further studies may be needed to refine the mosaic, and research will be included in the next 5-year priority period.

- Determine how abiotic factors influence abundances of plant-feeding insects that are prey base for many LCR MSCP species.

  Plant water content and nutrient content were studied for optimal concentrations to produce more insects (Work Task C5). In 2009, nitrogen was examined as a nutrient for spiders and insects that are prey of insectivorous birds at Beal Lake Restoration Area. In 2010, the amount of resilin, a digestible protein, and nitrogen content was determined for several insects and positively associated with beetles, flies, lacewings, true-bugs, dragonflies, and grasshoppers. In 2011, this study was expanded to investigate the element sulfur. Concentrations of sulfur were determined for 4 families of spiders and 22 families of insects. In 2012, the investigations will be expanded to examine phosphorous, another important nutrient for insect prey base species.

Species Research Proposed 2013–2017

- Refine habitat mosaic, including quailbush, nectar-producing plants, and mesquite for Macneill's sootywing and determine limiting abiotic factors of plants such as water needs, soil conditions, and nutritional needs (MRM2, MNSW1, and MNSW2).

System-Wide Monitoring Accomplishments 2008–2012

MacNeill's sootywing skipper utilizes dense quailbush and associated nectar-producing plant species as habitat. Quailbush has been mapped using digital imagery obtained in 2004.

- Potential skipper habitat will be visited to determine species distribution within the LCR MSCP area. Restoration sites targeting MacNeill's sootywing skipper should be located near existing skipper habitat.

  Surveys of host plants (Atriplex lentiformis) and eggs, larvae, and adults of MacNeill's sootywing (Hesperopsis gracielae) were conducted along the lower Colorado River from the inflows to Lake Mead to the Southerly International Boundary with Mexico (Work task C7). Atriplex surveyed throughout the LCR contained all life stages of sootywings.

System-Wide Monitoring Proposed 2013–2017

MacNeill's sootywing utilizes dense quailbush and associated nectar-producing plant species as habitat. Quailbush has been mapped using digital imagery obtained in 2004. Restoration sites targeting MacNeill's sootywing should be located near existing skipper habitat.

- Continue to monitor trends in sootywing populations throughout the LCR MSCP planning area.

Amphibians

Species Research Accomplishments 2008–2012

- Initiate studies on the ecology of the Colorado River toad and the lowland leopard frog, including population biology, limiting factors, and potential factors for population declines.

  A study on the distribution of the Colorado River toad and the lowland leopard frog was initiated in 2011 (Work Task D12). Once populations are located, this study will be expanded to determine the ecology, population biology, and limiting factors of these two species.

Species Research Proposed 2013–2017

- Finalize distribution studies of lowland leopard frogs and Colorado River toads (CRTO1 and LLFR1).

- Determine habitat preferences and basic ecology of lowland leopard frogs and Colorado River toads (CRTO1 and LLFR1).

- Determine the feasibility to translocate or create refugia for the lowland leopard frogs and the Colorado River toads, including determining if those parameters can be recreated at restoration sites (CRTO3 and LLFR3).

- Conduct a study/demonstration to create refugia and translocate lowland leopard frogs and Colorado River Toads to determine survivability of translocation (CRTO3 and LLFR3).

System-Wide Monitoring Accomplishments 2008–2012

Two evaluation species have system monitoring priorities under the LCR MSCP: the Colorado River toad and the lowland leopard frog. Conservation measures require the protection of occupied, unprotected habitat within the funding constraints of the LCR MSCP. To accomplish these conservation measures, the following 5-year priorities have been determined:

- Monitoring the current distribution of Colorado River toad and lowland leopard frog

A study on the distribution of the Colorado River toad and the lowland leopard frog was initiated in 2011 (Work Task D12). Once populations are located, this study will be expanded to determine the ecology, population biology, and limiting factors of these two species.

- Identifying occupied Colorado River toad and lowland leopard frog habitat for possible protection.

  Populations are currently being determined for these two species through Work Task D12. Once there are confirmed populations, these will be used to identify areas for possible protection. This will be completed during the next 5-year priority period.

System-Wide Monitoring Proposed 2013–2017

Two evaluation species have system monitoring priorities under the LCR MSCP: the Colorado River toad and the lowland leopard frog. Conservation measures require the protection of occupied, unprotected habitat within the funding constraints of the LCR MSCP. To accomplish these conservation measures, the following 5-year priorities have been determined:

- Continuing to monitor the current distribution of Colorado River toad and lowland leopard frog.

- Identifying occupied Colorado River toad and lowland leopard frog habitat for possible protection.

Wildlife Post-Development Monitoring

Accomplishments 2008–2012

Five-year priorities for monitoring restoration sites are similar for covered species that have conservation measures describing restoration goals. Prior to initiation of restoration projects, pre-development surveys will be conducted. After each restoration project or phase has been completed, post-development monitoring will occur for targeted covered species and their habitats. Species monitoring protocols will be similar to those used for system monitoring when appropriate. Habitat models will be created and tested to more efficiently monitor pre- and post-development. Decision support tools will be developed for managing created habitats to ensure these habitats provide the required site characteristics for targeted covered species. The 2008–2012 post-development monitoring priorities included:

- Evaluating protocols for monitoring covered species and their habitats at the site level.

  Post-development monitoring protocols have been developed for the covered species and their habitats. Most protocols follow similar or the same protocols as the system-wide surveys in order to be able to compare results.

- Developing habitat suitability index models for agricultural areas and other potential pre-development situations.

  A habitat suitability index model was not needed to determine whether agricultural areas were suitable covered species habitat. Pre-development surveys were conducted on a limited basis on agricultural fields to ensure that no covered species were located. Future pre-development surveys will no longer be needed for agricultural areas.

- Developing decision support tools for created habitats.

  The Restoration Conservation Measure Accomplishment Tracking Process was developed and approved by the Steering Committee during this priority period. The development of an internal process and spatial analysis for managing habitat for each of the species that have restoration goals has been initiated, and further development of the specific restoration management guidelines will continue through the next 5-year priority period. Additional support tools will be developed during the next 5-year priority period.

Because the LCR MSCP is a habitat-based program, presence/absence of covered species is not a requirement for determining success. However, information gained from the presence of targeted covered species will increase our ability to provide habitat requirements for these species.

Proposed 2013–2017

Post-development monitoring will be conducted in accordance with the LCR MSCP HCP as described in Section 5.11.4. Five-year priorities for monitoring restoration sites are similar for covered species that have conservation measures describing restoration goals. Prior to initiation of restoration projects, pre-development surveys will be conducted. After each restoration project or phase has been completed, post-development monitoring will occur for targeted covered species and their habitats. Species monitoring protocols will be similar to those used for system monitoring when appropriate. Support tools will be developed for managing created habitats to ensure these habitats provide the required site characteristics for targeted covered species. Because the LCR MSCP is a

habitat-based program, presence/absence of covered species is not a requirement for determining success. However, information gained from the presence of targeted covered species will increase our ability to provide habitat requirements for these species. The 2013–2017 post-development monitoring priorities include:

- Conducting covered species specific monitoring utilizing same or similar protocols to the system-wide surveys in order to determine occupancy, distribution, and population trends at restoration sites to assist in adaptively managing the site.

- Conducting monitoring to evaluate whether the site meets the conservation measures for credit determination, where appropriate, and to determine whether the sites are meeting the management guidelines to adaptively manage the site.

Wildlife Restoration Research

Accomplishments 2008–2012

Research strategies for conservation areas being developed primarily as wildlife habitat (cottonwood-willow, honey mesquite, or marsh habitats) target improving vegetation growth and survival, testing alternate propagation and habitat establishment techniques, determining restoration potential at identified sites based on current ecological functions, and evaluating technologies to assist in meeting specific habitat requirements. Short-term research to facilitate land cover establishment were expected to:

- Establish methods for collection and storage of plant propagates from native plants.

  A seed feasibility study (Work Task E8) documented the collection, storage, and germination of numerous native plants. The 3-year study expanded from a greenhouse to experimental plots and encompassed both cottonwood and Gooding's willow seed. Findings stated Fremont cottonwood, Goodding's willow, and coyote willow seed can be stored cleaned or uncleaned in freezers for over 2 years while retaining viability of greater than 80%, the optimal seeding method for Fremont cottonwood and Goodding's willow is hydroseeding on two furrows, establishment of undesirable species (primarily saltcedar and grasses) can be controlled by reducing the seed bank on and adjacent to revegetation areas and by spraying revegetation areas with grass-specific herbicide during the first growing season, and seeding can potentially reduce costs of planting by up to 60% over mass planting. Upon completion of the small-scale seed plots, the decision was made not to implement the large-scale (20-acre) plot due

to high variability in success of establishment of native trees, large percentage of weeds with an inherent fire risk, and the success of mass transplanting either from cuttings or seed.

- Identify and evaluate techniques for propagating key plant species.

  Propagation of riparian species has been successfully standardized through contracted services. Specific techniques of collection, handling, treatment, and transplanting of propagated stock have been examined and are being utilized in current restoration activities.

  A seed feasibility study (Work Task E8) documented the collection, storage, and germination of numerous native plants. This 3-year study looked at the possibility of utilizing seed versus propagation by cuttings. The study determined that direct seeding resulted in variable establishment success for Gooding's willow and, to a lesser extent, Fremont cottonwood. Rather than taking plant cuttings, seeds are now being germinated in the greenhouse, which may expand the genetic diversity of transplants. See the bullet above for additional findings of the study.

- Control invasive and/or exotic plant species.

  Conservation areas have been designed with dense plantings of native species and cover crops to directly control non-native species until the site reaches a more closed canopy structure. After sites are planted, they are managed to control invasive and/or exotic plant species where needed. Specific management activities included control of morning glory, tamarisk, buffel grass, and psyllids on honey mesquites.

  An integrated pest management approach will be developed as part of the conservation area management plans for each LCR MSCP conservation area in the 2012–2017 priority period.

- Minimize water usage.

  The addition of a soil amendment was investigated as one possible method to increase irrigation efficiency and reduce the number of irrigation cycles required within a season. A demonstration using Lassenite Pozzolan, a commercially available soil amendment, was implemented within the Beal Lake Conservation Area. Lassenite Pozzolan was recommended from the 2007 report, Feasibility of Using Soil Amendments to increase Water Retention at Restoration Sites on the Lower Colorado River, as a material that would increase the moisture holding capacity of sandy soils, not decompose, and make water and nutrients available to plants by adsorbing and releasing them slowly over time.

In 2010, Reclamation conducted laboratory tests using Lassenite Pozzolan at the Technical Service Center in Lakewood, Colorado. Three tests were designed to address questions and concerns about using the product under the conditions created by flood irrigation. Results showed that Lassenite Pozzolan did not move through the soil column, increased the moisture holding capacity of sandy soil, and allowed water to move laterally across the soil surface more efficiently.

Following the positive lab results, a field trial was conducted during the winter of 2012. A complete description of the trial is available in the Beal Lake Restoration Site Amendment Study: Irrigation Monitoring and Instrumentation Report. Based on the results of the field scale trial, no significant difference was found in irrigation time between the field treated with Lassenite Pozzolan and the control. Also, there was no significant difference in gravimetric water content between treatment and control. Given these results, Lassenite Pozzolan will not be employed at other restoration areas for the purposes of increasing irrigation efficiency. Data are being collected to evaluate Lassenite Pozzolan's moisture holding capacity.

Informed changes to irrigation practices have the greatest potential to reduce water use at our restoration sites without compromising the quality of the habitat. A research study was conducted to inform irrigation treatments at creation sites composed of monotypic stands of trees. Research conducted at the Cibola National Wildlife Refuge in 2010 found no effect of irrigation treatment (shallow, frequent versus deep, infrequent) on Fremont cottonwood mortality or growth rate, implying that Fremont cottonwood preferentially select groundwater as their water source. Additionally, the study determined Gooding's willow mortality increased under a deep, infrequent watering regime. The complete findings of this study are documented in the 2010 Cibola National Wildlife Refuge Field 51 Vegetation Monitoring Report.

The final phase of the Groundwater and Soil Salinity Monitoring Network in Support of Long-Term Irrigation and Salt Management of MSCP Restoration Areas study will culminate with the submission of management strategies informed by a model incorporating variables that influence soil and groundwater salinity. The report and recommendations will be submitted for review in fall 2012. If the recommended strategies are useful and can be implemented by the LCR MSCP, the established monitoring network will be expanded beyond the three restoration sites currently being monitored.

Proposed 2013–2017

Restoration or created habitat research is being conducted in accordance with the LCR MSCP HCP as described in Section 5.11.3. This research will be conducted to answer questions surrounding the creation of native aquatic, marsh, and riparian communities. Research may include creation-related activities such as seed collection and dispersal, irrigation techniques, and soil conditioning techniques. This information will be used adaptively to inform implementation and management of restoration sites.

- Collect information on soil moisture, develop soil moisture standards, and standardize soil moisture units for management.

- Assess restoration sites riparian tree genetic diversity (and the need for) and then, if necessary, conduct research on how to incorporate greater genetic diversity in riparian planting of created habitats through propagating trees through seed and selecting and planting individuals from various locations along the Colorado River drainage.

- Continue to monitor groundwater and soil salinization to develop techniques to mitigate or prevent salinization of groundwater and/or soils at created habitat sites for long-term success and sustainability.

- Conduct research to determine cost-effective management techniques and determine timing and extent of management actions necessary for maintaining structural diversity in riparian habitats.

- Research alternate methods for site characterization, such as remote sensing or spatial modeling tools, to assist with adaptive management and program-wide decisions.

- Conduct research and monitoring to evaluate cost-effective fuel reduction methods, if necessary, to assist with adaptive management.

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